basket without hesitation the many poor attempts to fabricate the funnel cloud of a tornado. We received one such not very long ago from Mr. Connor. It was better than the average, and instead of going into the trash basket it went into a convenient drawer. Now we are glad that we kept it, for along comes a photograph kindly sent us by Mr. Gosewisch, of the tornado cloud that brought death and destruction to so many homes in Kirksville, Mo., on April 27, 1899.

We thought we had seen that tornado cloud before, and the more we looked at it the more certain we were that we had met an old friend. When we first saw it our funnel cloud was stirring up the dust and incidentally frightening the inhabitants of Waynoka, in far-off Oklahoma, and this was more than a year ago. The scene has now changed to a quiet road in Missouri across which our Oklahoma tornado cloud appears to be crossing, while a couple of artistic Rubens watch its progress in wonder and amazement. The job is well done. There is no particular fault to be found either with the conception or the execution, but it pains us to think that people will take such liberties with the business end of a tornado. Only to think, "It was taken at 100 yards!" We sincerely hope that the pioneer who "took it at 100 yards" will some day meet a real robust tornado.

For the edification of the readers of the MONTHLY WEATHER REVIEW we print the two pictures on Plate I. On the left-hand is the Waynoka picture, on the right-hand is that for Kirksville. The Waynoka tornado is mentioned at page 201 of the REVIEW for May, 1898, where it is said to have begun about 6:30 p. m., central time, about 3 miles west of Waynoka, on Tuesday, May 17. The date, May 24, given on the back of the Waynoka photograph is probably an error of one week.

It is possible that the Waynoka picture was made by superposing a tornadic funnel upon a beautiful photograph of sunset clouds and landscape. The Kirksville picture retains the funnel and clouds of the Waynoka picture, but substitutes a view of a road and its osage hedges, such as might occur in Missouri. But where did the original funnel come from? It is evidently not a photograph from nature of a genuine tornado funnel. It has every appearance of having been drawn in india ink on glass and then photographed by printing upon the landscape negative. The retouching of original negatives so as to convert a portrait from nature into a beautiful work of art is carried on in great perfection by modern artists, but any application of this art to photographs that are to be used for scientific purposes does more harm than good.

The latest turn in the history of this picture has been given by its publication in the Philadelphia Press of Sunday, June 23, 1899, where our Kirksville picture with its Missouri landscape appears as "the Waynoka tornado of May 18, 1898, at about 1,000 feet distance." This change of distance would seem to have been necessitated by the perspective distance inherent in the beautiful Missouri landscape; the change of date is possibly a misprint.

We shall doubtless see the Waynoka clouds and funnel reproduced again, at no distant date, in connection with some other dreadful disaster. The argument seems to be: "If there was a disaster, it must have been a tornado; if a tornado, it must have had a funnel; if a funnel, there must be a picture; this is a photograph, therefore it will do."

THE METEOROLOGICAL SERVICE OF CANADA.

By Prof. R. F. STUPART, Director.

The Meteorological Service of Canada is an organization maintained by the Dominion Government and is a branch of the Department of Marine and Fisheries.

The work of the Service comprises the issue of weather forecasts for the benefit of shipping, fishing, and agricultural interests, the collection of climatological data for purposes of agriculture and the information of immigrants, etc., and scientific meteorological research.

There are now in the Dominion 304 stations at which observations are taken with instruments supplied by the Government and which report to the Central Office, Toronto. They are divided as follows: 4 first order, 65 second order, 206 third order, and 89 rainfall stations.

At Banff, in the Rocky Mountains at an altitude of 1,384 meters, there is at present a station of the second order, and within the next year it is hoped that we shall be able to establish a station with self-recording instruments on the top of Rundle Mountain within a few miles of Banff at an altitude of 2,921 meters. Thirty-seven stations report by telegraph twice daily, and two stations, St. Johns, N. F., and Bermuda once daily; these two latter although not in the Dominion are maintained by the Dominion Government. Almost invariably all reports from stations between Lake Superior and Cape Breton are received in the Central Office by 8:30 a. m. and p. m. and then forwarded without delay to the United States Weather Bureau at Washington via Buffalo, N. Y., from which place some 60 United States stations are in return sent to Toronto, together with the Canadian reports from Manitoba westward to British Columbia. All reports are usually received shortly after 9:30 and the working chart is ready for the forecasting official by 9:45, and by 10 o'clock the isobars have been drawn and some of the forecasts telegraphed to their destination. The bulletin issued at night comprises a short synopsis of the weather during the past day and generally a description of the existing meteorological conditions, then a list of the highest and lowest temperatures recorded at about a dozen stations, followed by the forecasts for the various districts lying between Manitoba and the Maritime Provinces. These forecasts are for the twenty-four hours beginning at the following 8 a. m. unless it be expressly stated that they cover a longer period. That same evening the telegraph company sends the bulletin to all points where morning newspapers are published, in which it is generally printed at the head of the column of local news, and then in the morning on the opening of the various telegraph offices throughout the Dominion the first message which goes over the wires is the daily forecast, which is posted up in a conspicuous place in every telegraph office. Up to the summer of 1894 the forecast based on the 8 p. m. was practically the only one issued, but since that time a second forecast covering the current and following day has been issued at 10 a. m. This is sent to nearly all ports, both on the Great Lake and on the seaboard, and arrangements have recently been made whereby it appears in most of the afternoon newspapers published in the Dominion.

There are in the Dominion 70 stations at which cautionary and storm signals are displayed—32 on the Lakes and 38 in the Maritime Provinces. The signals used are drums and cones, the cone alone being hoisted when but a moderate gale is expected, and both drum and cone together when it is thought that the storm will be heavy. The apex of the cone downward indicates southerly and easterly directions and upward northerly and westerly.

As a means of disseminating more generally the forecasts among the farming community during the summer season, white discs, indicating "fine," "showers," or "rain," are placed each afternoon on the baggage vans of outgoing trains, being the forecasts for the next day.

Each morning some seventy-five copies of the weather chart are made by means of a duplicating machine, the mimeograph, and supplied to a few subscribers, to the Toronto newspapers, to the board of trade, and to such business people who engage to post them where they will be seen by the public.

Until the summer of 1898 forecasts were not issued for portions of the Dominion lying west of Manitoba, but arrangements were then made whereby telegraphic reports from stations near the Pacific coast, together with about 12 United States stations, furnished through the courtesy of the Chief of the Weather Bureau, are forwarded twice daily to Victoria, B. C., at which place the agent of the Meteorological Service is local forecast official, and now issues regular daily forecasts based on a weather chart nearly as complete as will be possible until telegraphic communication be established with more northern portions.

The Canadian Service fully appreciates the necessity of extending its system of meteorological stations over the northern part of the Continent, and we now have observations taken at Herschel Island, in the Arctic Sea,[1] Hay River, latitude —° —′ north, longitude —° —′ west; Fort Simpson, latitude 61° 52′ north, longitude 121° 43′ west; Fort Churchill, latitude 58° 51′ north, longitude 94° 11′ west; York Factory, latitude 57° 0′ north, longitude 92° 28 west; Moose Factory, latitude 51° 16′ north, longitude 80° 56′ west; Martins Falls, latitude 51° 30′ north, longitude 86° 30′ west; Fort Chipewyan, 58° 42′ north, 110° 10′ west; Fort Good Hope, latitude 66° 20′ north, longitude 128° 25′ west; Norway House, latitude 53° 58′ north, longitude 97° 52′ west; and at Dawson and several other points in the Yukon. Bidaily telegraphic reports are received from Barkerville, B. C., the farthest north telegraph station on the Continent, and it is probable that in the near future Dawson may be added to the list.

It may be added that the Dominion Magnetic Observatory, now situated at Agincourt, 9 miles from the Central Meteorological Office and 6 miles from any lines of electric tramway, is under the supervision of the Director of the Meteorological Service.

AN ADVANCE IN MEASURING AND PHOTOGRAPHING SOUNDS.[2]

Prof. BENJAMIN F. SHARPE, M. A.—(Dated Greenwich, N. Y., June 1, 1899.)

THE NATURE OF THE PROBLEM.

Since the passage of sound through the air consists in alternate condensations and rarefactions, a direct measurement of the intensity of sound must measure these changes in atmospheric pressure. Practically this has been very difficult to do for two reasons: first, because these pulsations follow each other so rapidly. Middle C on the piano, for instance, has 256 condensations, each followed by a rarefaction, making 512 distinct pressure maxima and minima in a single second; evidently no ordinary instrument for measuring pressure, such as the barometer, would serve in this case. But the second and greater difficulty lies in the fact that these condensations are so exceedingly minute, being indeed from a hundred thousand to a million times smaller than the pressure differences that can be read on an excellent mercurial barometer.

Consequently the energy acting upon the ear drum in case of the faintest, audible sound is of the same order of magnitude as the energy falling upon the retina from the faintest star visible to the naked eye, a star of the 6th magnitude; while the energy of a sound of maximum intensity (at this point the ear ceases to distinguish which of two tones is the louder) is about as much as that involved in the growth of a single, ordinary blade of grass in June. So in every case we are dealing with very minute quantities of energy.[1]

There are a great variety of sounds to be measured, but for convenience we may group them all into three great classes: noises, musical notes, and pure tones. Of these pure tones are the simplest, for they consist of a definite number of pulsations per second, and the pulsations follow each other at equal intervals. A tuning fork affords a good example. If it be struck gently, it produces a faint tone, if it be struck harder a louder tone is heard, but the sound does not change in character or in pitch; only the intensity of the tone changes. If we wish to change the pitch, a fork of different dimensions must be taken. Consequently there are two measurements to be made in studying even the simplest sound, viz, loudness or intensity, and pitch or frequency, the latter being the number of pulsations per second. A musical note is some combination of pure tones, whose frequencies bear a simple ratio. But the choice of the component tones, as well as their relative intensities, determines the differences in quality or timbre, such, e. g., as the difference observed between the same note produced on the flute and on the violin. A musical note, accordingly, has to be analyzed into its component tones before the note is fully determined. We might naturally suppose that a further distinction might be made based on the differences of phase arrangement possible in a note, but it is found that the ear does not appreciate these differences, though the photographic instrument herein described makes them evident to the eye. If now we add to a note a single tone whose frequency does not bear a simple ratio to the other component tones of the note, a discordant sound or noise results. And even though a particular noise contained a hundred tones and not a single simple ratio, its complete determination would involve nothing more than the determination of the frequencies and intensities of all the component tones at the given instant. Of course these components may be continually changing from moment to moment. In fact noises are hardly ever constant in either loudness or quality, and this fact, together with the very great variety of frequencies, which the component tones may have, renders it so difficult to completely determine a noise, that as yet this has never been done. But our instrument will photograph a noise as well as any other sound, and by the aid of the photograph we may determine its principal component tones, and also the intensity of the noise.

AN INSTRUMENT TO MEASURE SOUND.

We would naturally begin with the simplest case in working toward a sound-measuring instrument, and fortunately this is also the case of the greatest physical importance, since all the theoretical laws concerning the propagation of sound assume a pure tone. To test these laws, or rather to derive

[1] Latitude, 69° 25′ north; longitude, 138° 53′ west, near the mouth of the McKenzie River.—ED.

[2] The work here described was done recently by the author, Prof. B. F. Sharpe, while a Fellow in Clark University, following a suggestion made by Professor Webster. A much more detailed, technical account of the apparatus and the associated mathematical theories will be published later. This general, preliminary account has been prepared for the MONTHLY WEATHER REVIEW at the request of the Editor in the belief that the instruments and methods here given will prove serviceable in certain special meteorological investigations, since the faintest waves of pressure are recorded by the apparatus.

There are many acoustic phenomena observed in the atmosphere whose analysis, with the help of proper apparatus, ought to give us methods of determining the velocity of any movement going on in the air, the temperature of the air, the disturbances produced by warm bodies, by the explosions that attend meteors, lightning, cannonading, etc., and especially those that attend the formation of rain, hail, and snow. It is not for the ordinary Weather Bureau observer to conduct these delicate investigations; they are the special province of the mathematical physicist and laboratory expert. To the latter meteorology must look for the further building up of this branch of our science. It is likely that the study of the vagaries of the sounds from fog signals, which has been prosecuted by our Lighthouse Board without the help of Professor Sharpe's ingenious apparatus, would become more precise and satisfactory if his methods could be applied to that study. Meteorology has much to hope from the proper study of sound waves, which are, in fact, only minute waves of barometric pressure and Professor Sharpe's methods take up the subject where the ordinary barograph fails on account of its sluggishness.—ED.]

[1] Wien, Ueber die Messung der Tonstärke, Berlin. 1888, p. 47.